ECOSYSTEM STATUS INDICATORS

Groundfish

Relationships between EBS flatfish spatial distributions and environmental variability from 1982-2004

Principal Investigator – Paul Spencer (Alaska Fisheries Science Center – REFM)
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Previous studies have noted that the relationship between habitat use of EBS flatfish (as measured by CPUE from summer trawl surveys) and temperature has generally remained constant over time (Swartzman et al. 1992), motivating the hypothesis that flatfish may shift distributions in order to maintain temperature preferences. Recent bottom temperatures in the EBS show considerable contrast and thus provide opportunity to examine the relationship of flatfish distributions to temperature variability. For example, 1999 was one of the coldest years on record and a warming trend has occurred since 2000 such that 2003 and 2004 were two of the warmest years observed. The average latitude and longitude, by year, of the EBS shelf survey stations within the "cold pool" (defined as water < 2˚C) was computed, as well as the annual centroids (average latitude and longitude of survey stations containing a particular species, weighted by EBS shelf survey CPUE). Ellipses of fish distributions were centered on the centroids and were computed as contour encompassing a probability of 50% for a bivariate normal distribution. Locations of the cold pool centers and the distribution ellipses were then contrasted between the years with the five lowest (1999, 1994, 1995, 1986, and 1992) and highest (2003, 1996, 2004, 1998, and 2002) mean temperatures since 1982.

For flathead sole and rock sole, the location of the distribution ellipses were related to environmental conditions (Figure 71a). The center of the cold pool was located further to the southeast during the cold years, and three of the five warmest years observed in the 1982-2004 time series have occurred since 2002, providing evidence of the recent warming trend. The locations of the distribution ellipses for flathead sole and rock sole are generally located further to the north or northwest during the warm years (shown in red) relative to cold years (shown in blue). In particular, the northern boundaries of the distribution ellipses for rock sole in each of the warm years are located farther north than the northern boundaries from each of the cold years. In contrast, although Alaska plaice distributional ellipses have moved slightly they do not show a correspondence with environmental conditions (Figure 71b).

Correlation analysis was used to assess the relationship between the proportion of the population distribution (based upon survey CPUE) located in the southeast EBS shelf survey strata (south of a line extending from approximately from the north end of Kuskokwim Bay to the Pribilof Islands) to the proportion of the cold pool located in the southeast survey strata. The time series were standardized by subtracting the mean and dividing by the standard deviation. Significant correlations with the cold pool location were found for rock sole and flathead sole, but non-significant relationships for other species (Figure 72). For flathead sole and rock sole, relatively small proportions of the population (low standardized values) are found in the southeast strata during warm years in which a relatively small portion of the cold pool is located in this area. This finding suggests that flatfish habitat selection is related not only to sea floor characteristics, but is also influenced by temporally varying environmental conditions.

The diet of flathead sole consists of a greater proportion of fish than other small flatfish, and one hypothesis is that flathead sole distributions may be linked to prey fish populations which in turn may be related to temperature. For rock sole, density-dependent changes in growth and population distribution have also been observed (Walters and Wilderbuer 2000), confounding the results observed here. Ongoing research is currently investigating models that simultaneously evaluate the effects of population density and environmental variability.

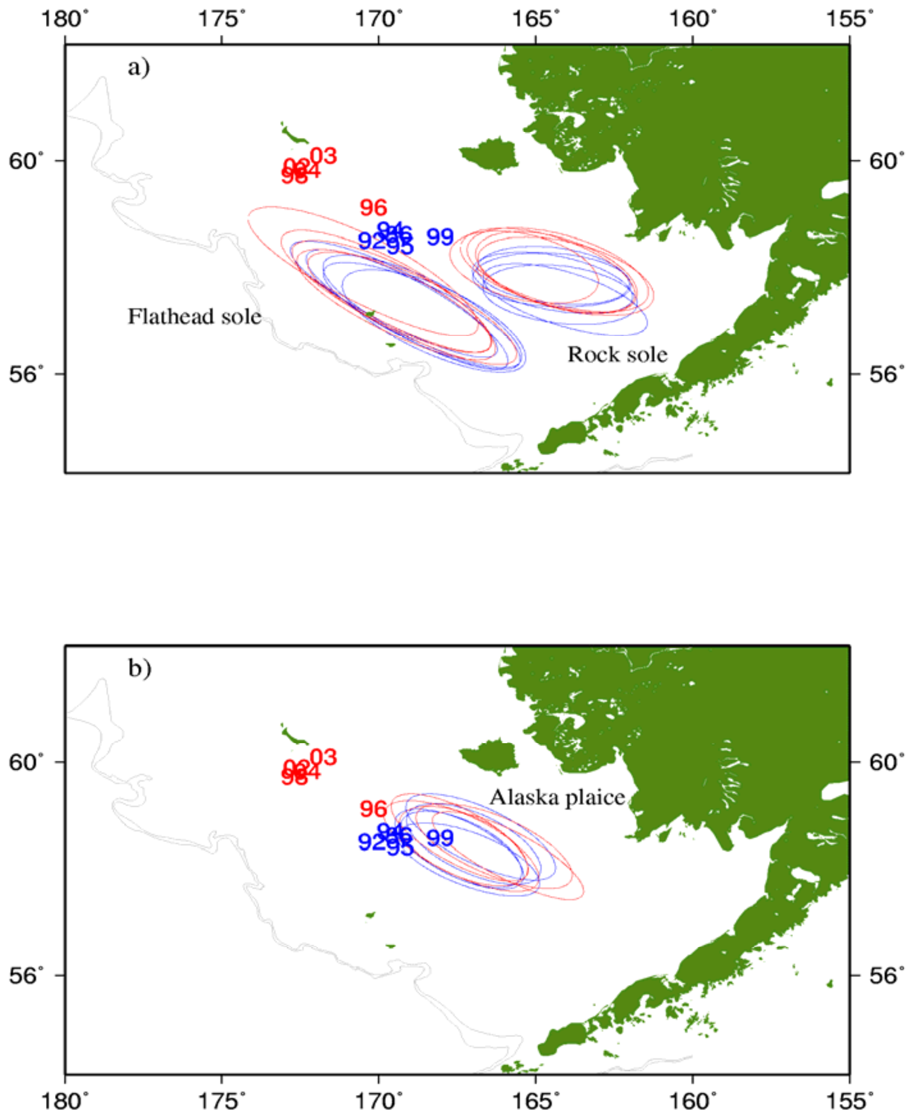

Figure 71. Centers of the cold pool, label by year, from the five warmest (red) and coldest (blue) years observed from 1982-2004, and the distributional ellipses encompassing a probability of 50% for a bivariate normal distribution (based upon EBS shelf survey CPUE data) for flathead sole and rock sole (a) and Alaska plaice (b).

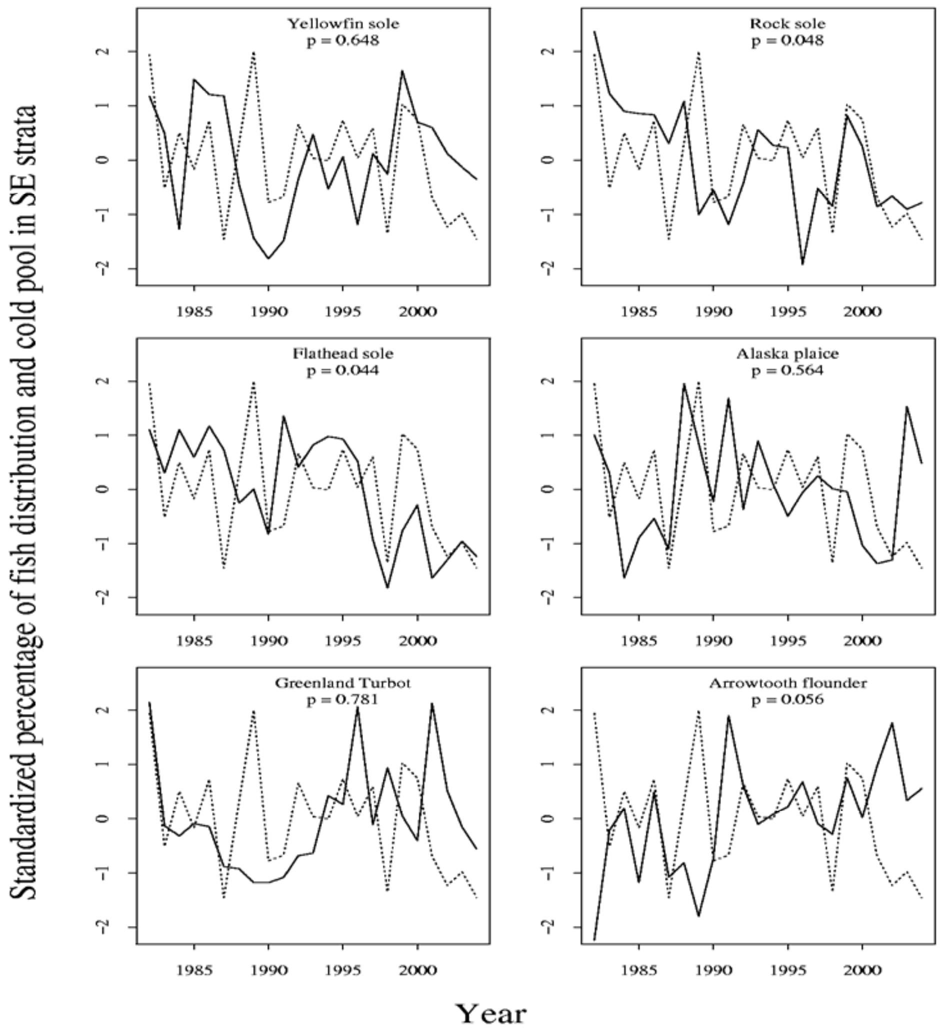

Figure 72. Time series of the standardized proportions of fish populations (solid lines) and proportion of the cold pool (dashed lines) located in the southeast EBS shelf survey strata. Data were standardized by subtracting the mean and dividing by the standard deviation; positive values indicate relatively higher percent with the SE survey strata.